CLAIMS

1. An elongate waveguide for guiding light, comprising:

a core region, comprising an elongate region of relatively low refractive index; and

a cladding region, comprising elongate regions of relatively low refractive index interspersed with elongate regions of relatively high refractive index, including, in a transverse cross-section of the waveguide, a relatively high refractive index boundary region that surrounds the core region and has either (1) at most two-fold rotational symmetry or (2) a rotational symmetry that reduces the rotational symmetry of the waveguide to at most two-fold rotational symmetry, the symmetry of the boundary region resulting at least in part from azimuthal variations therein, which are substantially uncharacteristic of the cladding region.

2. A waveguide according to claim 1, wherein the boundary region has at most two-fold rotational symmetry at least in part due to azimuthal variations in a property of the boundary region.

3. A waveguide according to claim 1 or claim 2, wherein the boundary region has at most two-fold rotational symmetry at least in part due to azimuthal variations in its thickness, shape, refractive index or other material properties.

4. A waveguide according to any one of the preceding claims, wherein the boundary region comprises a plurality of relatively high refractive index boundary veins joined end-to-end around the core region at boundary nodes, each boundary node being joined between two boundary veins and to at least one relatively high refractive index region of the cladding region.

5. A waveguide according to claim 4, wherein the boundary region has at most two-fold rotational symmetry at least in part due to one or more boundary veins having different properties than other boundary veins.

6. A waveguide according to claim 4 or claim 5, wherein the boundary region has at most two-fold rotational symmetry at least in part due to one or more boundary veins having a different thickness, shape, length, refractive index or other material property than other boundary veins.

7. A waveguide according to any one of claims 4 to 6, wherein the boundary region has at most two-fold rotational symmetry at least in part due to one or more boundary nodes having different properties than other boundary nodes.

8. A waveguide according to any one of claims 4 to 7, wherein the boundary region has at most two-fold rotational symmetry at least in part due to one or more boundary nodes having a different size, shape, refractive index or other material property than other boundary nodes.

9. A waveguide according to any one of the preceding claims, wherein the boundary region comprises an inner periphery and an outer periphery, which has a substantially different form than the inner periphery.

10. A waveguide according to claim 9, wherein the combination of the forms of the inner periphery and the outer periphery result in the boundary region having at most two-fold rotational symmetry.

11. A waveguide according to any one of the preceding claims, wherein the boundary region comprises a plurality of boundary cells around the core region.

12. A waveguide according to claim 11, wherein the boundary region has at most two-fold rotational symmetry at least in part due to differences in one or more of the characteristics of the boundary cells.

13. A waveguide according to claim 11 or claim 12, wherein the boundary cells together do not tile onto any arrangement of cells in the cladding region.

14. A waveguide according to any one of the preceding claims, wherein, the cladding region comprises an array of relatively low refractive index regions in a matrix of relatively high refractive index regions.

15. A waveguide according to claim 14, wherein, the array, apart from the boundary region, is substantially periodic.

16. A waveguide according to any one of the preceding claims, wherein, the cladding region, apart from the boundary region, has a highest rotational symmetry that is less than or equal to two.

17. A waveguide according to any one of claims 1 to 15, wherein, the cladding region, apart from the boundary region, has a rotational symmetry that is greater than two.

18. A waveguide according to any one of the preceding claims, wherein, the core region, apart from the boundary region, has a highest rotational symmetry that is less than or equal to two.

19. A waveguide according to any one of claims 1 to 17, wherein, the core region, apart from the boundary region, has a rotational symmetry that is greater than two.

20. A waveguide according to any one of the preceding claims, wherein the core region includes a hole.

21. A waveguide according to claim 20, wherein the hole is filled with a material other than air.

22. A waveguide according to any one of claims 1 to 19, wherein the core region does not include a hole.

23. A waveguide according to any one of the preceding claims, wherein at least some of the relatively high refractive index regions comprise fused glass.

24. A waveguide according to any one of the preceding claims, wherein at least some of the relatively low refractive index regions comprise a hole.

25. A waveguide according to any one of the preceding claims, having a beat length, which is less than 10mm at a given wavelength.

26. A waveguide according to claim 25, in which the given wavelength is in the region of 1550nm, 1310nm, 1060nm or 800nm.

27. A waveguide according to any one of the preceding claims, wherein, in use, the two polarization states of a spatial mode of the waveguide exhibit significantly different field decays at a given radial distance from the centre of the waveguide.

28. A waveguide according to any one of the preceding claims, wherein the amount by volume of relatively lower refractive index material in the cladding region exceeds 50%.

29. An optical fibre comprising a waveguide according to any one of the preceding claims.

30. An optical transmission system incorporating an optical fibre according to claim 29.

31. A method of forming a photonic crystal fibre including the steps:

forming a preform comprising an elongate, relatively low refractive index core region, and, surrounding the core region, an elongate cladding region, comprising elongate regions of relatively low refractive index interspersed with elongate regions of relatively high refractive index;

forming, at the interface between the core region and the cladding region, a boundary region, comprising one or more relatively high refractive index regions, which has at most two-fold rotational symmetry due to azimuthal variations, which are uncharacteristic of the cladding region; and

drawing the pre-form into a fibre, which has no more than two-fold rotational symmetry about any longitudinal axis.

32. A method according to claim 31, including forming the pre-form from a plurality of elongate members, at least some of which are capillaries.

33. A method according to claim 31, including forming the pre-form by extrusion.

34. A method of forming a birefringent photonic crystal fibre comprising the steps:

arranging a plurality of elongate members, at least some of which are capillaries, into a pre-form stack comprising an elongate cladding region enclosing an elongate core region, the members in the cladding region forming a characteristic pattern, apart from at least one member in a boundary region, at or near to the core region, which breaks the characteristic pattern and renders the boundary region, in the transverse cross-section, no more than two-fold rotationally symmetric about any axis; and

drawing the pre-form stack into a fibre, which has no more than two-fold rotational symmetry about any longitudinal axis.